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B.Tech. Degree V Semester Special Supplementary Examination August 2015

ME 504 THERMAL ENGINEERING

(2006 scheme)

Time : 3 Hours Maximum Marks : 100

PART A

(Answer *ALL* questions)

$(8 \times 5 = 40)$

I. (a) Draw the PV and TS diagram of Diesel cycle and derive the efficiency equation.

(b) Draw the valve timing diagram of a four stroke diesel engine.

(c) Explain the working of an opposed piston engine with a neat sketch.

(d) Explain the combustion phenomenon in SI engine.

(e) Write the effects of friction on steam nozzle.

(f) Derive the condition for maximum work done in terms of blade speed ratio of steam turbine.

(g) Explain the effects of reheating in a gas turbine.

(h) Draw and explain a closed cycle gas turbine.

PART B

$(4 \times 15 = 60)$

II. (a) An engine of 250 mm bore and 375 mm stroke works on Otto cycle. The clearance volume is 0.00263 m^3. The initial pressure and temperature are 1 bar and 50°C. If the maximum pressure is limited to 25 bar, find the following: (10)

(i) The air standard efficiency of the cycle

(ii) The mean effective pressure for the cycle.

Assume the ideal conditions.

(b) Explain different methods of scavenging. (5)

OR

III. (a) The following data refer to a car engine having 4 cylinders. (10)

Bore = 75 mm; stroke = 90 mm; engine to rear axle ratio 39:8; wheel diameter with tyre fully inflated 650 mm. The petrol consumption for a distance of 3.2 km when car was moving at a speed of 48 km per hour was found to be 0.227 kg.

If the mean effective pressure is 5.625 bar, determine the indicated power and thermal efficiency. Calorific value of petrol may be taken as 43470 kJ/kg.

(b) Explain Stirling cycle. (5)

IV. Enumerate the functions of lubricating system in an internal combustion engine. Draw and explain the lubrication systems used in an internal combustion engine. (15)

OR

V. (a) Draw and explain the combustion chambers used in spark ignition engines. (10)

(b) Differentiate pre-ignition and auto ignition in an engine. (5)

VI. (a) A DeLavel type impulse turbine is to develop 150 kW with a probable consumption of 7.5 kg of steam per kWh with initial pressure being 12 bar and the exhaust 0.15 bar. Taking the diameter at the throat of each nozzle as 6 mm, find the number of nozzles required. Assuming that 10 percent of the total drop is lost in diverging part of the nozzle, find the diameter at the exit of the nozzle and the quality of steam which is to be fully expanded as it leaves the nozzle. (10)

(b) Explain pressure compounding in steam turbines. (5)

OR

VII. (a) In a single stage steam turbine saturated steam at 10 bar abs. is supplied through a convergent – divergent steam nozzle. The nozzle angle is 20° and the mean blade speed is 400 m/s. The steam pressure leaving the nozzle is 1 bar abs. Find; (8)

(i) The best blade angles if blades are equiangular
(ii) The maximum power developed by the turbine if the number of nozzles used are 5 and area at the throat of each nozzle is $0.6\ cm^2$.

(b) Explain the phenomenon of super saturated flow in steam nozzle. (7)

VIII. The pressure ratio of an open – cycle gas turbine power plant is 5.6. Air is taken at 30°C and 1 bar. The compression is carried out in two stages with perfect intercooling in between. The maximum temperature of the cycle is limited to 700°C. Assuming the isentropic efficiency of each compressor stage as 85% and that of turbine as 90%, determine the power developed and the efficiency of the power plant, if the air flow is 1.2 kg/s. The mass of fuel may be neglected, and it may be assumed that $C_p = 1.02$ kJ/kgK and $\gamma = 1.41$. (15)

OR

IX. A centrifugal compressor running at 10,000 r.p.m. delivers 660 m^3/min of free air. The air is compressed from 1 bar and 20°C to a pressure ratio of 4 with an isentropic efficiency of 82%. Blades are radial at outlet of impeller and flow velocity of 62 m/s may be assumed constant throughout. The outer radius of impeller is twice the inner and the slip factor may be assumed as 0.9. The blade area co-efficient may be assumed 0.9 at the inlet. Calculate; (15)

(i) Final temperature of air
(ii) Impeller diameter at the inlet and outlet
(iii) Breadth of impeller at inlet
(iv) Theoretical power
(v) Impeller blade angle at inlet
(vi) Diffuser blade angle at inlet.

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